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Taxonomic Notes of *Hesperosoma* (*Hemihesperosoma*) *miwai* (Bernhauer, 1943) with Observations of Uncommon Behavior (Coleoptera: Staphylinidae)

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Abstract. Since its original description in 1943, *Hesperosoma* (*Hemihesperosoma*) *miwai* (Bernhauer, 1943) has been redescribed by multiple authors (Hayashi, 1993a; Schillhammer, 2015), albeit without having seen the type specimen. In our study, the holotype specimen of *Amichrotus miwai* Bernhauer, 1943 was examined, and it was concluded that all subsequent redescriptions of this species are in line with its type specimen. We also provide additional distribution data for *H.* (*Hem.*) *miwai*, confirming that this species is endemic and widespread throughout the island of Taiwan. In addition, a possible phytophagous behavior was discovered during field observations. The plant-associated behavior of several Staphylininae species is also discussed within our study.

Key words: Rove beetle, Staphylininae, Staphylinini, Anisolinina, *Alocasia odora*, type specimen, distribution, bionomics, field observation, Taiwan

Introduction

Hesperosoma (*Hemihesperosoma*) *miwai* (Bernhauer, 1943) is a species of rove beetle endemic to Taiwan. The species was first described by Bernhauer (1943), originally in the genus *Amichrotus*. Shibata (1976) accepted the generic concept of Bernhauer and described another new species of *Amichrotus* from Taiwan. Later, Hayashi (1993a) placed *Hesperosoma* in his newly established the subtribe Anisolinina, and moved *A. miwai* to the genus *Hesperosoma*, redescribing this species. In that same year, Hayashi (1993b) described a subspecies of *H. miwai* (*H. miwai nanshanchiana*) and *H. sakoi* based on limited material. Schillhammer (2009) synonymized both *H. miwai nanshanchiana* and *H. sakoi* as *H. miwai* based on a series of specimens. Schillhammer (2015) redescribed *H. miwai* in his revision of *Hemihesperosoma*. However, both authors (Hayashi, 1993a and Schillhammer, 2015) did not examine the type specimen of *A. miwai*.

Most Staphylininae are thought to be exclusively predacious on other invertebrates, with only a few examples of phytophagy having been observed in this subfamily (Thayer, 2016). In some cases, phytophagous staphylinines are also presumed to be pollinators, based on mandibular modifications, and the fact that they are frequently collected from flowers (Smetana, 1971, 2002, 2012, 2015). García *et al*. (2012) reported *Philonthus quisquiliarius* (Gyllenhal, 1810) to be the first known case of a zoophytophagous staphylinine, i.e. a principally zoophagous (predacious) animal that occasionally exhibits phytophagous behaviour within a single life stage (Coll & Guershon, 2002).

Based on limited collection data, staphylinines in the subtribe Anisolinina are thought to occur in various forest floor habitats such as in leaf litter, on fungi, or under large fallen trees, although the majority of specimens have been collected in flight intercept traps (Shibata, 1976; Schillhammer, 2004, 2009, 2015, 2018; Tang, 2019). Schillhammer (2004) briefly mentioned that some specimens of *Hesperosoma* were collected from mushrooms on decaying trees in mountain forests, hunting for larvae feeding on the mushrooms; he suggested that this habitat requirement likely applies to most members of the *Anisolinus* lineage. However, based on collection data, some members of *Hesperosoma* seem to switch to other microhabitats (e.g. *H.* (*Hesperosoma*) *puetzi* was collected by sifting in a spring-fed swamp or mixed shrubs and grassland (Schillhammer, 2004, 2009); *H.* (*Hes.*) *tarasovi* was collected by fogging in montane rainforest (Schillhammer, 2009); *H.* (*Hem.*) *pederseni* was collected in a fruit-baited trap on the ground (Schillhammer, 2009).

In the present paper, the first author examined the type specimen of *A. miwai*. Based on field observations, we aim to report on the association between *H. miwai* and the plant *Alocasia odora* (Alismatales: Araceae). Additional distributional data for *H. miwai* is also provided.

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Materials and methods

Images of the type specimen and labels were taken using an Olympus OM-D E-M1 digital camera with an Olympus M.Zuiko Digital ED 30mm F3.5 Macro lens. The image of the type specimen was montaged using the Z-stacking technique; the method followed that described in Hu & Ho (2019). Images of live specimens were either taken using a Nikon D500 digital camera with a 105mm f2.8 Micro Lens and Phottox Mitro+ Flash, or using an HTC U11+ smartphone. The habitat image was taken using a Nikon D500 digital camera with an 18-55 mm f3.5-5.6 Lens and Phottox Mitro+ Flash. Images were edited in Adobe Photoshop CS5 as needed. Formatting of plates was done in Adobe Illustrator CS5 and PhotoCap 6.0. For the collection data, double slash (//) is used to separate different labels, while supplementary data are provided in square brackets ([]).

Depositories.
FMNH — Field Museum of Natural History, Chicago, USA (C. Maier, A. F. Newton, M. Thayer).
FSHc — Fang-Shuo Hu, private collection, Taichung, Taiwan.
NMNS—National Museum of Natural Science, Taichung, Taiwan (J.-F. Tsai).
TARI — Taiwan Agricultural Research Institute, Taichung, Taiwan (C.-F. Lee).

Results

Hesperosoma miwai (Bernhauer, 1943)

(Figs. 1–2)

Type material. Holotype (male) (Fig. 1) by monotypy, in FMNH: Formosa, Arisan [=Alishan=阿里山], 1918//X 2 – 23. J. Sonsan, M. Yoshino//amichrotus miwai Bernh Typ.//miwai Bernh, typus amichrotus [red label]//Chicago NHMus. M. Bernhauer Collection. The specimen is in poor condition, separated in three parts (head, thorax and abdomen). All parts of the specimen are mounted on a card. Most segments of both antennae and tarsi of the left hind leg and right middle leg are missing, as well as the distal two tarsomeres of the left middle leg. Both hind wings are sticking out from the elytra, part of right hind wing is attached to the terminal segment of abdomen. The holotype specimen of *Amichrotus miwai* fits all descriptions from previous authors (Bernhauer, 1943; Hayashi, 1993b; Schillhammer, 2015).

Additional material. TAIWAN: Hualien County: 1 spec., 台 8 線 140.5~141K (8C-1), 05.VII.2010, leg. W.-P. Chan (TARI); 1 spec., 台 8 線 158~158.5K (5B-1), 05.X.2010, leg. W.-P. Chan (TARI); 1 spec., same data as previous one except (5A-1), 09.X.2010 (TARI); 1 spec., same collection data as preceding, 12.VI.2010 (TARI); 1 spec., 台 8 線 164~164.5K (4A-1), 27.VI.2010, leg. W.-P. Chan (TARI); 1 spec., same data as previous one except (4B-3), 19.VI.2010 (TARI); 1 spec., Pulowan (布洛灣) (2B-2), 20.III.2010, leg. W.-P. Chan (TARI); 1 spec., same data as previous one except (2A-1), 04.XII.2010 (TARI); 1 spec., Loshao (洛韶), 07-14.IV.2007, leg. Y.-F. Hsu// *Hesperosoma miwai* (BERNHAUER) det. Schillhammer '09 (TARI). Nantou County: 1 spec., Jenai Sungkang [仁愛 松崗], VI/17/1998, C.C.Lo (NMNS); 4 spec., Shitou (溪頭), 12.V.2005, leg. C.-F. Lee// *Hesperosoma miwai* (BERNHAUER) det. Schillhammer '09 (TARI); 1 spec., same data as previous ones except 7.IV.2005 (TARI). New Taipei City: 1 spec., FORMOSA, Aode [=澳底], 27-IX-1938, COL. Y. MIWA (TARI). Yilan County: 7 spec., Linmei (林美), 24.8207, 121.7214, ca. 510m, Jiaoxi To., 04~11-III-2018, leg. F. S. Hu by FIT (FMNH, FSHc); 1 spec., Fushan Botanical Park [福山植物園], 19-26.VI.2006, leg. C.-S. Tung (TARI). Yunlin County: 2 males and 3 females, Jiananyun Peak (嘉南雲峰), alt. 1795m, 30.VIII.2018, in rotten bamboo, leg. C. R. Chen (FSHc). Pingtung County: 1 male, Tai-wu, Tai-wu 泰武, 1200m, 2019,II-19, Y. T. Chung Leg. CCCC (FSHc).

Distribution.

Hesperosoma miwai is endemic and widespread in Taiwan. Based on previous studies (Bernhauer, 1943; Shibata, 1976; Naomi, 1982; Hayashi 1993a; 1993b; Schillhammer, 2009; 2011; 2015) and this paper, this species is recorded from Chiayi County, Hualien County, Nantou County, New Taipei City, Taoyuan City, Taitung County, Yilan County and Yunlin County, presumably occurring in mountainous areas of Taiwan Island.

Bionomics.

As with most other *Hesperosoma* spp., *H. miwai* are usually collected using flight intercept traps. A series of specimens from Jiananyun Peak were collected from rotten bamboo. Based on collection data, *H. miwai* has been collected from relatively low elevations (e.g. Linmei, alt. 510 m) to relatively high elevations (e.g. Jiananyun Peak, alt. 1795 m).

Description of behavior based on field observations.

While live specimens of *H. miwai* are roosting or moving, the mandibles are always closed and overlapping (Fig. 2A). However, based on a field observation made by the second and third authors in Defulan Trail, Taichung City (24.1805, 120.9762), a live specimen of *H. miwai* was found inside the base of a decaying stem of a still live *Alocasia odora* (Fig. 2C); this individual was observed biting the decaying stem (Fig. 2B) several times over a period of a few seconds. Shortly after, this individual escaped, and was thus unable to be vouchered, however, since there are no similar *Hesperosoma* spp. known in Taiwan, the identification is assumed to be correct.

A series of *H. miwai* specimens were collected from Jiananyun Peak, Yunlin County (23.6037, 120.7246) by the fourth author. These specimens were found inside decaying bamboo (Fig. 2D). Two males and three females were collected at the same time: see 'Additional material' below for details. Both observations suggest that *H. miwai* presumably has a close association with decaying plant material.

Figure 1. Type specimen and labels of *Amichrotus miwai* Bernhauer, 1943.

Figure 2. Live specimens of *H. miwai* (Bernhauer, 1943) and its microhabitats. A - Live roosting specimen of *H. miwai* with closed mandibles; B - Live specimen of *H. miwai* biting rotten stem of *Alocasia odora*; C - The rotten stem of *A. odora*; D - Live specimen of *H. miwai* found in rotten bamboo.

Discussion

There are few reports in the literature of rove beetles of the subfamily Staphylininae utilizing different sources of plants. Frank & Barrera (2010) reported adults of *Belonuchus* spp. and *Odontolinus fasciatus* hunting lepidopterous or dipterous larvae in water-filled flower bracts of various species of *Heliconia* (Zingiberales: Heliconiaceae). Rodríguez & Navarrete-Heredia (2016) described a new species of *Belonuchus* which was collected from rotten Agavoideae (Asparagales: Asparagaceae); the type series of *Philonthus euphorbiarum* was collected from the trunk of dead *Euphorbia officinarum* (Malpighiales: Euphorbiaceae); specimens of *Smilax lynchi* have been collected under fallen fruit (Chatzimanolis, 2016).

In our observation, *H. miwai* was biting the rotten stem of *Alocasia odora*. In fact, a similar behavior has been observed in *B. cephalotes* (see Frank & Barrera: Fig. 7) but the authors did not explain this behavior in detail. Though the feeding behavior of *H. miwai* was not observed directly, one may assume this specimen was feeding on the sap of the decaying stem of the *A. odora*. Both our observations suggest that *H. miwai* is also associated with decaying plant material. Answering the question of whether *H. miwai* really is a zoophytophagous species will require confirmation through more detailed observations and experiments. Our study provides a preliminary record for further natural history studies of this species.

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三輪鐮顎隱翅蟲分類補述與罕見行為觀察（鞘翅目：隱翅蟲科）

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摘要: 三輪鐮顎隱翅蟲 *Hesperosoma miwai* (Bernhauer, 1943) 已經被重複描述數次，但模式標本卻從未被重新檢查，本篇文章重新檢查三輪鐮顎隱翅蟲的模式標本，所有重新描述皆符合模式標本。本文亦更新本種的分布資訊，確認本種為特有種且廣布於臺灣本島。本文亦報導了此種可能的取食植物行為，並與其他隱翅蟲亞科 (Staphylininae) 物種的類似行為一併討論。

關鍵詞: 隱翅蟲、隱翅蟲亞科、隱翅蟲族、岐隱翅蟲亞族、姑婆芋、模式標本、分布、生物學資訊、野外觀察、臺灣